Cryogenic Summary - Testing D2L109 in MAGCOOL

11/26/03

- Description
- Operating Summary
- Tests Performed
- Detail Operation
- Test Conditions
- Summary

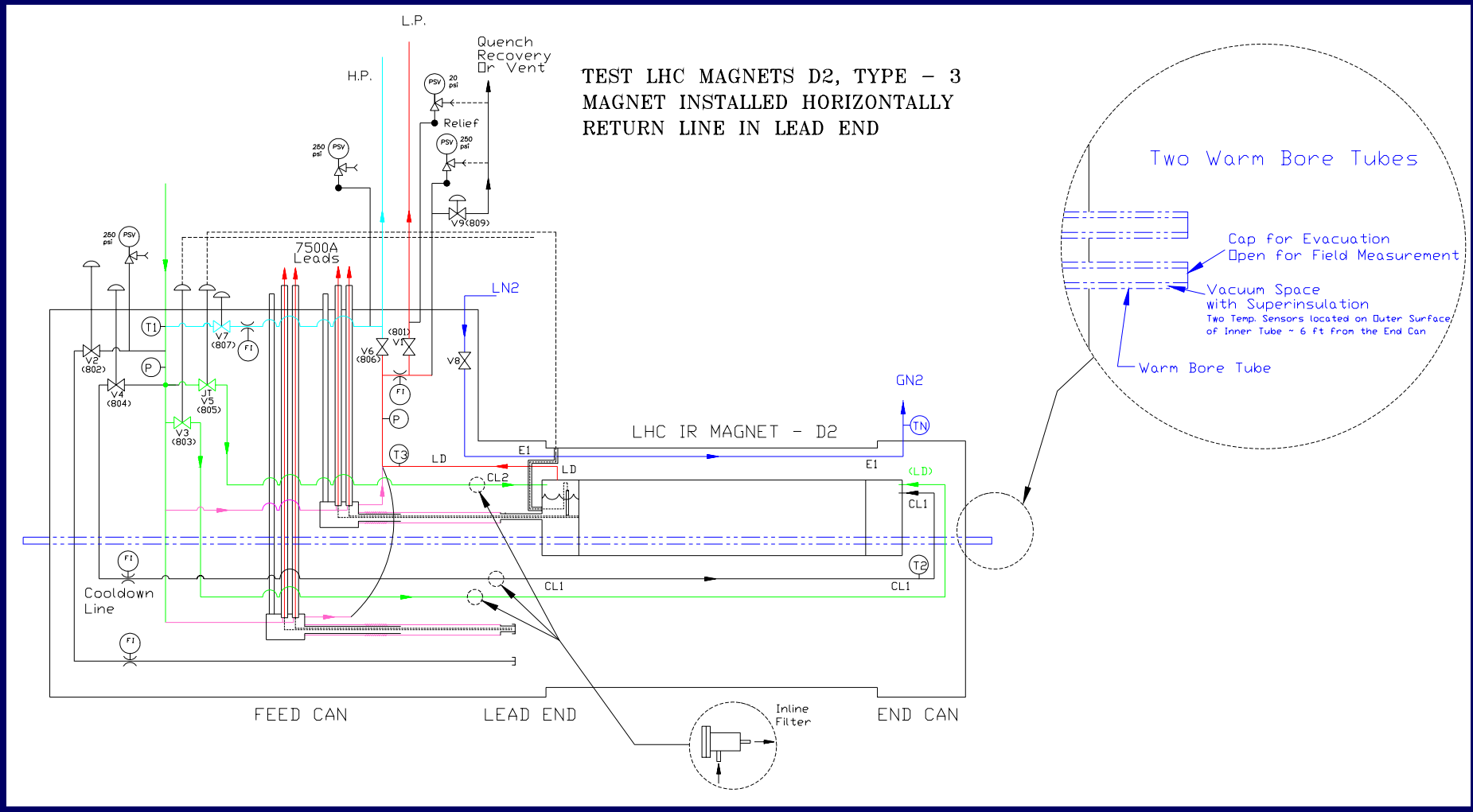
Specific of D2L109 Test

- Filters are installed downstream of the cooldown and two JT supply lines to prevent any chance of oil contamination - similar to testing D2L105, 106 and 107 and 108.
- During 100 K cooldown of D2L109, we experienced minor flow restriction (sign of contamination) as seen with D2L107. Able to eliminate flow restriction with one reverse flow back to warm return.

General Description - D2L109

- The magnet is installed horizontally on test bay – 0% slope.
- Cooldown/warmup supply in non-lead end, helium return from lead-end.
- In liquid cool mode, JT flows are fed mainly from non-lead end with some from lead end.
- Warm bore tubes inserted and evacuated during quench tests.
- Warm bore tubes are open for field measurements.
- Information on the Warm Bore Tube and measuring device can be obtained from
    - A. Marone - andym@bnl.gov
    - G. Ganetis – ganetis1@bnl.gov
    - D. Sullivan – dans@bnl.gov

Flow diagram of D2L109 with Warm Bore Tubes, Three Filters, 0% Slope and Return Line from the Lead End.

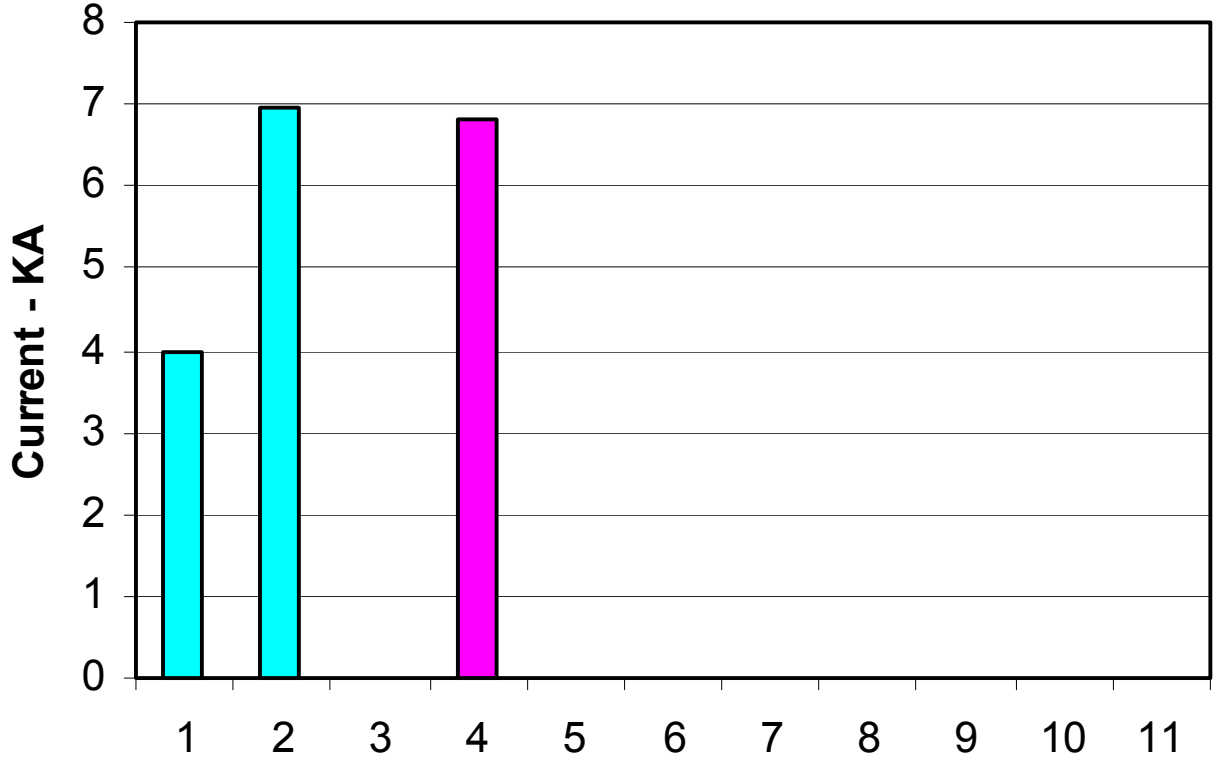


Tests Performed for D2L109

- 1st test group (forced flow cooling ~ 4.6 K),
  - Shut off - 1000 A (11/17)
  - Shut off - 4000 A (11/17)
  - Strip heater – 4000 A (11/17)
  - 1st quench – 6958 A (11/17)

- 2nd test group (liquid cool ~ 4.6 K),
  - 1st quench - 6825 A (11/21)

Quench Performance of D2L109
(Warm Bore Tubes Evacuated)



Operation (11/12 – 11/17/03)

- 11/12 Start Cooldown at 4 pm
- 11/13 Cooldown I
- 11/14 Cooldown I
- 11/15 CD I Complete at 17:00
  Started 5 K cooldown using E19 & E20
- 11/16 Reach 50 K in the morning due to E20 tripped overnight
  Continue 5 K cooldown using E19 & E20
- 11/17 Reach 4.6 K test condition in the morning
  Perform cold check, shut off and strip heater quenches.
  1st quench 6958A.

Operation (11/18 - 20)

- 11/18 Field measurement –
  Perform 1 AC cycle and 5 DC loops for left bore.
- 11/19 E19 tripped overnight due to unstable air pressure to DOV7C
  Use E19 & E20 to cool the system down
  10:30 start to perform field measurement.
  Perform 1 AC cycle and 5 DC loops.
  Rd-do cycle #8.
  Complete field measurement for left bore.
- 11/20 Perform 1 AC cycle and 10 DC loops in 12 hours. Complete field measurement for right bore.

Operation (11/21 - 24)

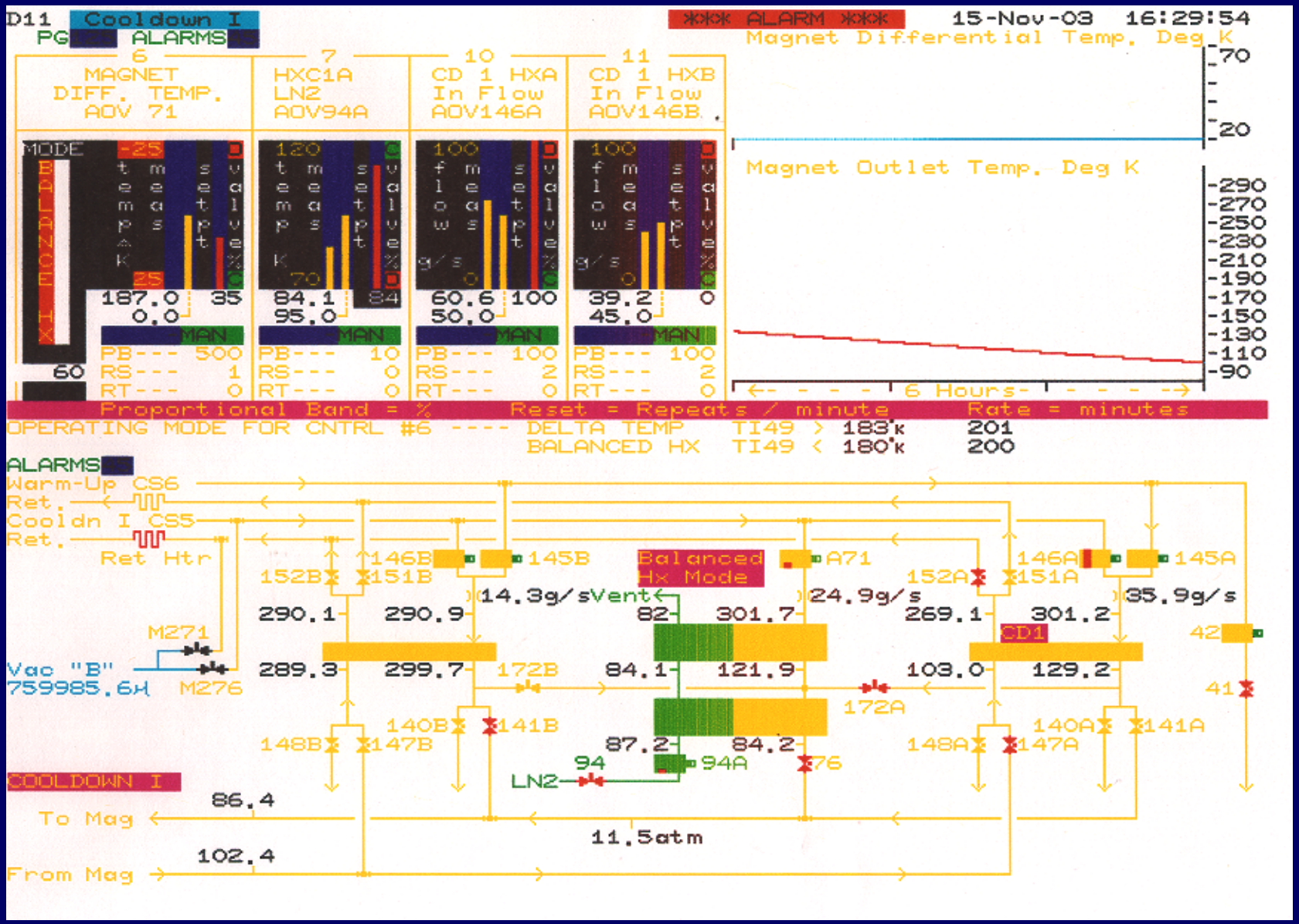
- 11/21 Switch to liquid cool.
  Quench – 6825 A.
  Start warmup.
- 11/24 Complete warmup.

Test Conditions

- Forced flow cooling - 12 atm, 4.6 K & ~ 60 g/s
  (Warm bore tube evacuated)

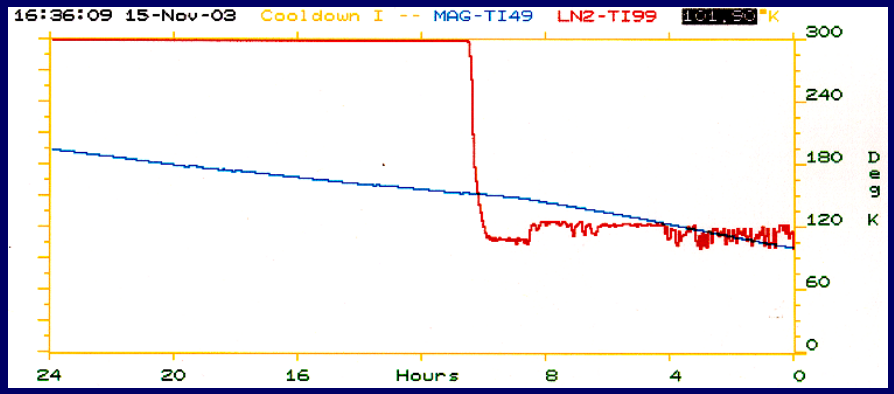
- Liquid helium cooling – 1.43 atm, ~ 4.6 K
  Liquid level ~ 74% (~ 7 cm above coil,
  ~ 8 cm below vent)
  in both lead end and non-lead end
  (Warm bore tubes evacuated for ~ 2 hours)

Operating Condition for 100 K Cooldown of D2L109



Cooldown from 300 – 100 K for D2L109

(11/12 – 11/15/03)

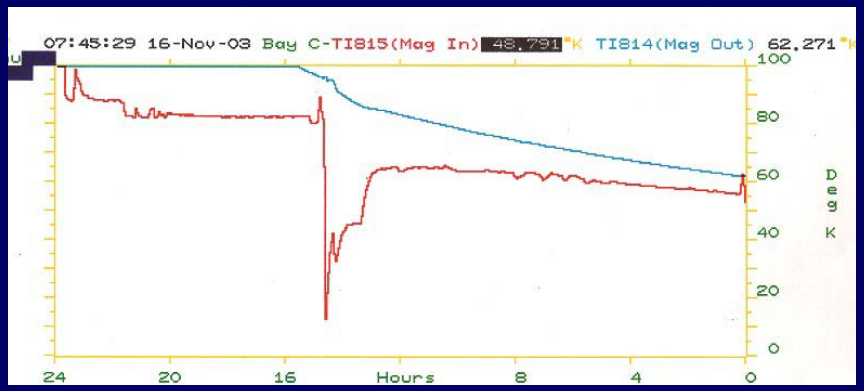


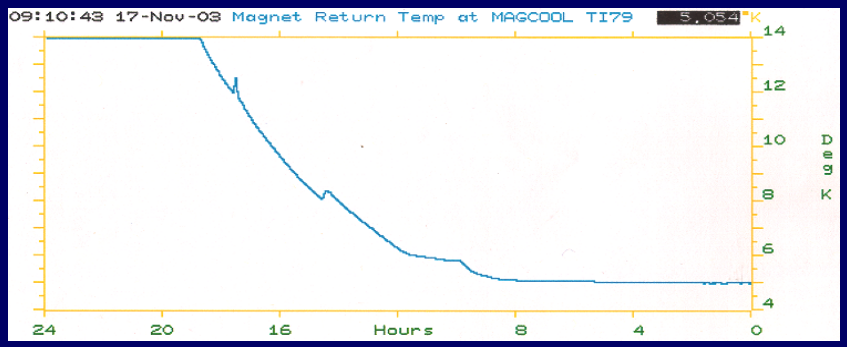
- Cooldown time (300 to 100 K) is ~ 72 hours, cooldown rate is very slow

- Cooldown Controller is set to manual when return is ~ 150 K.
  Fully open AOV146A. Open AOV71 35%. Temperature (TI51) is about 272 K at return of CD heat exchanger. Open LN2 valve AOV94 to 85%. Total flow to D2 is ~ 55 g/s and supply temperature (TI48) is about 85 K.

Cooldown from 100 – 5 K for D2L109

(11/15 – 11/16/03)

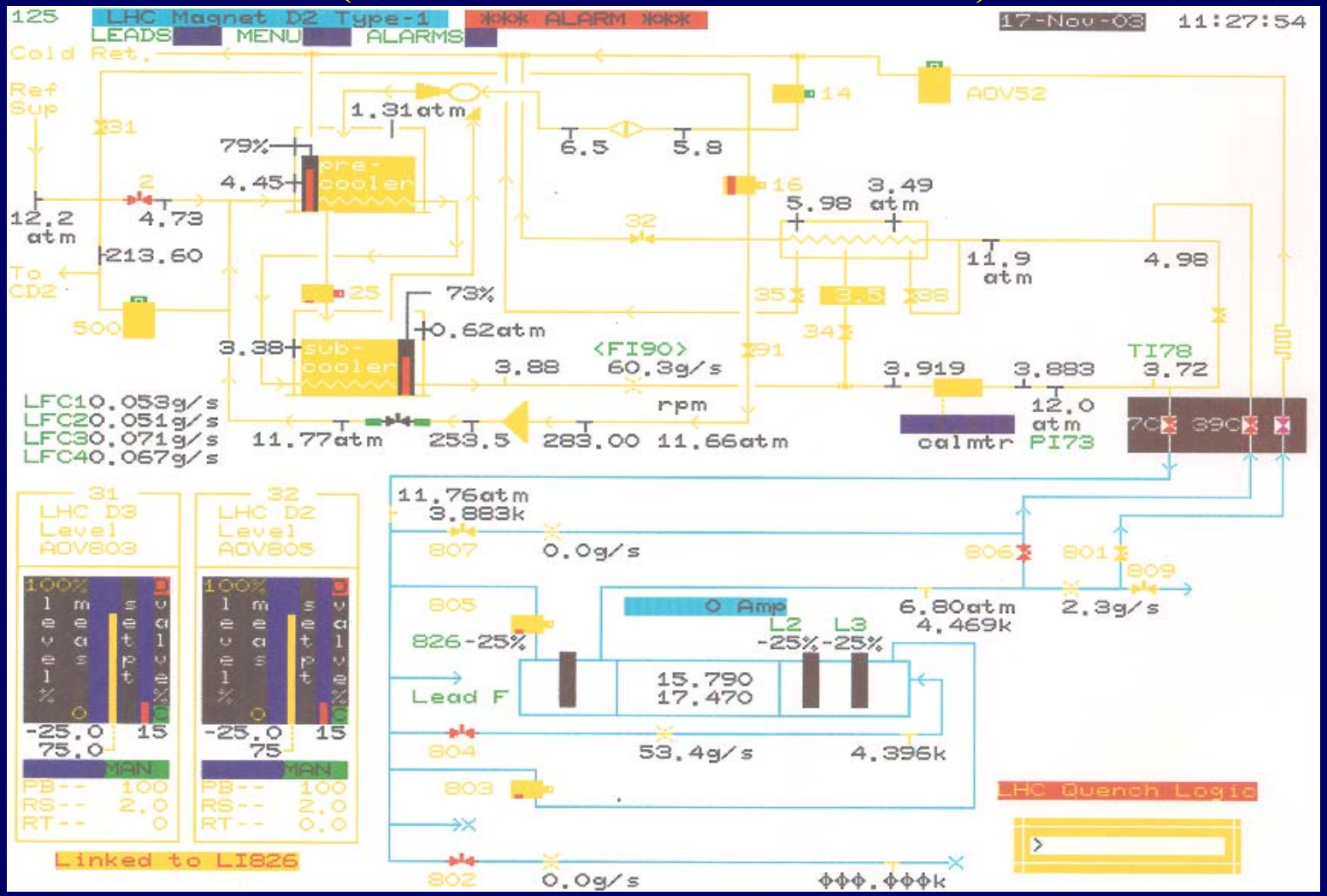




- Cooldown time (100 to 58 K) is ~ 15 hours, using E19 (E20 tripped overnight).
- Cooldown time (58 to 4.6 K) is ~ 18 hours, using E19 & E20.

Forced Flow Cooling of D2L109 Prior to 4000 A Ramping, similar condition is used for 6958 A ramp

(Warm Bore Tube Evacuated)



Current Leads

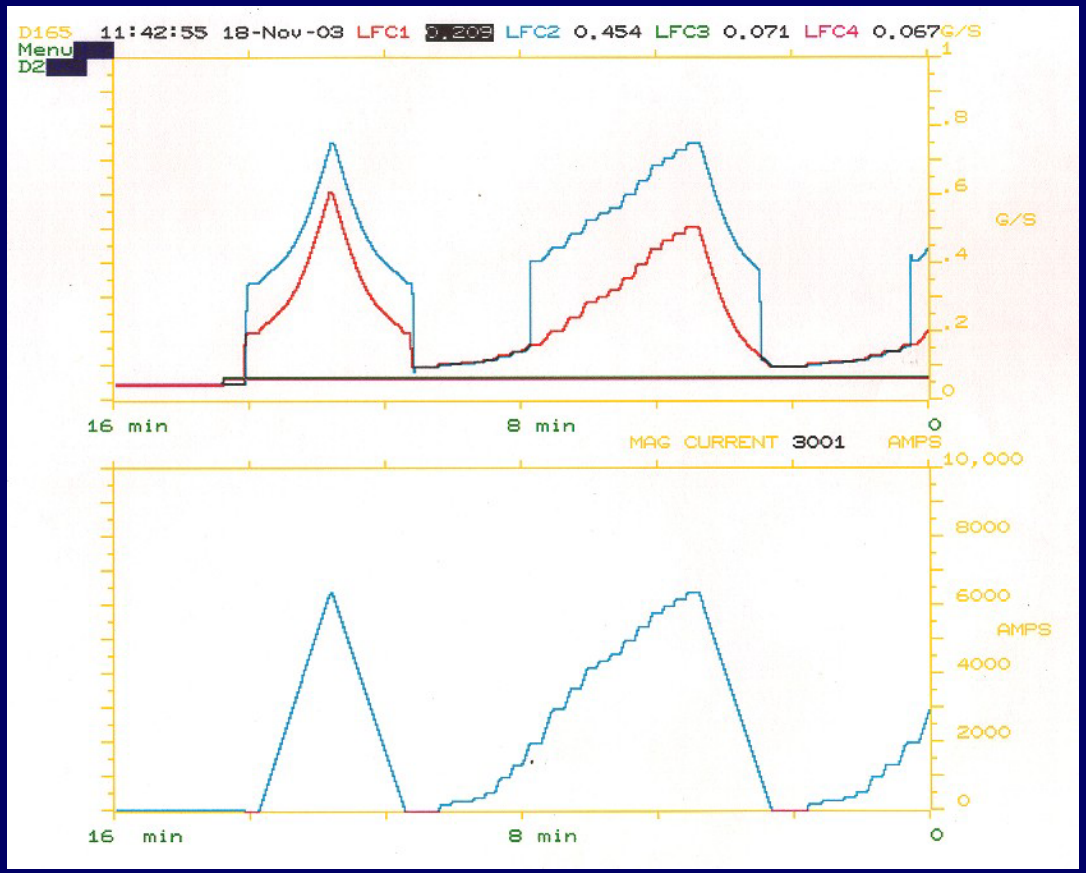
- Operate same way as previous D2 magnets.
- Separate flow controllers for the 7500 A leads. The (-) lead demands more flow than the (+) lead
  - For quench test at 20 A/s ramp rate,
    - The tare flow are 0.20 g/s for (+) lead and 0.35 g/s for (-) lead
    - Wait ~ 2 minutes at 5000 A for the (-) lead to recover the voltage developed before ramping current above 5000 A.
    - After reach the operating current, warm end of the leads could become cold. Small reduction in Tare flow is needed.
    - Unused leads are set at 0.050 g/s for forced cooling and are set at 0.100 g/s for liquid cool.

Lead Flow and Current for AC Cycle (left) and DC loop (right) are the same as previous D2

Upper Figure: Lead Flow – Blue for (-) Lead and Red for (+) Lead.

Lower Figure: Current as a Function of Time (Time scale is incorrect, 16 min actually means 120 min)

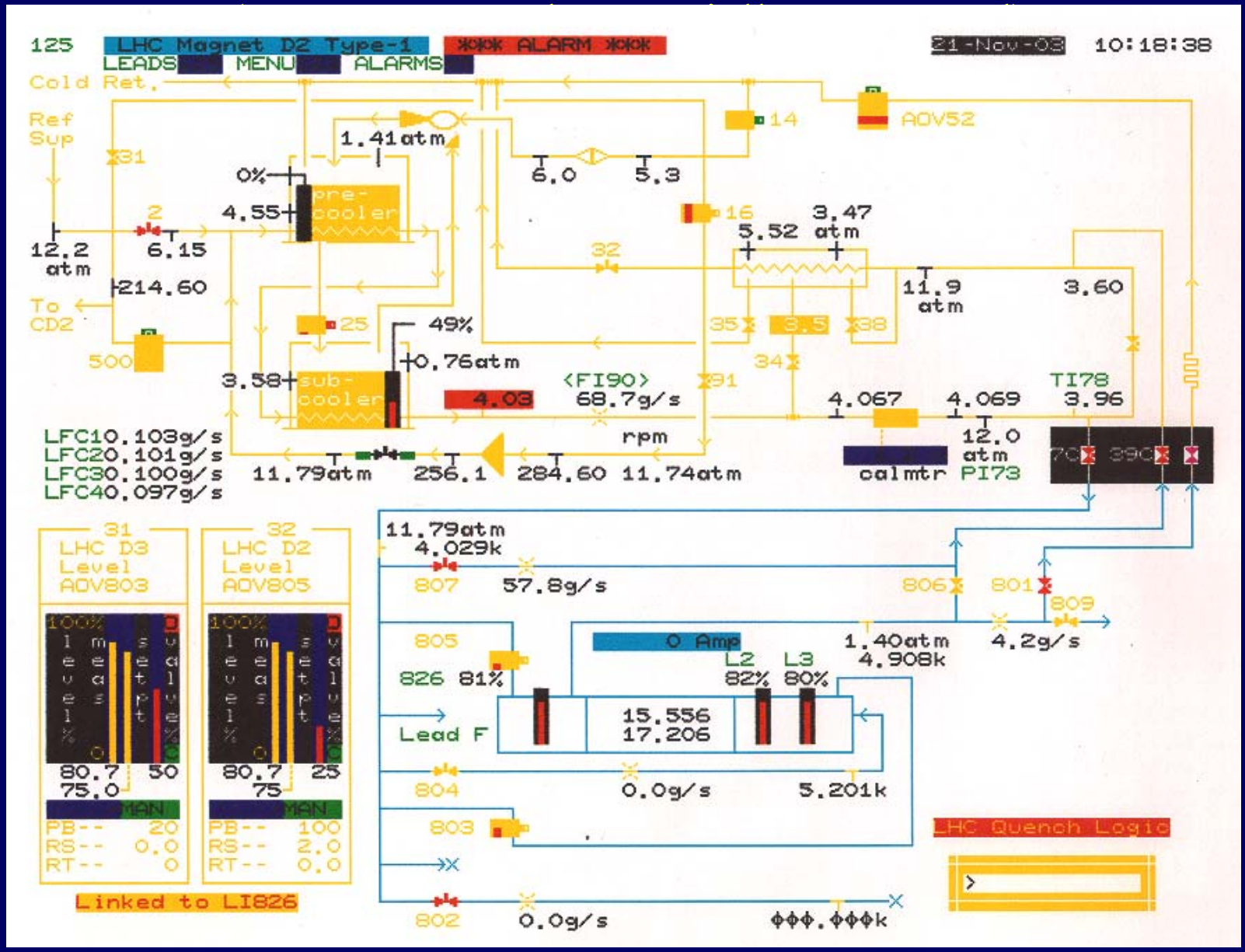
Ramp rate is 10 A/s and is ramped to 6400 A.



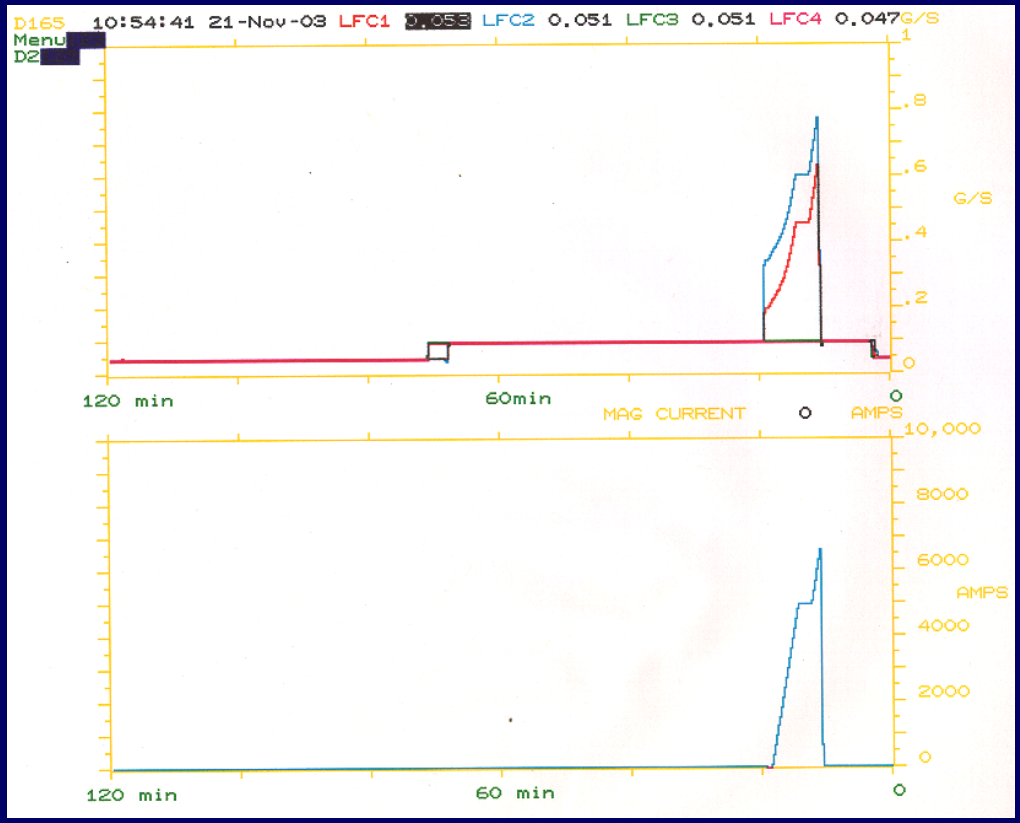
Current Leads

- Flow control for AC cycle and DC loop are the same as that for D2L104, 105, 106, 107 & 108
  - For AC cycle at 10 A/s ramp up directly to 6400 A,
    - Tare flow is ~ 0.15 g/s for (+) lead
    - Tare flow is ~ 0.38 g/s for (-) lead
  - For DC loop at 10 A/s with 70 seconds stop at various pre-selected currents,
    - The tare flow is 0.10 g/s for (+) lead for all currents
    - The tare flow is 0.10 g/s for (-) lead below 2000 A and 0.35 g/s afterward, (or reduced back to 0.10 g/s below 2000 A with stop during ramp down)
- Unused leads are set at 0.070 g/s.

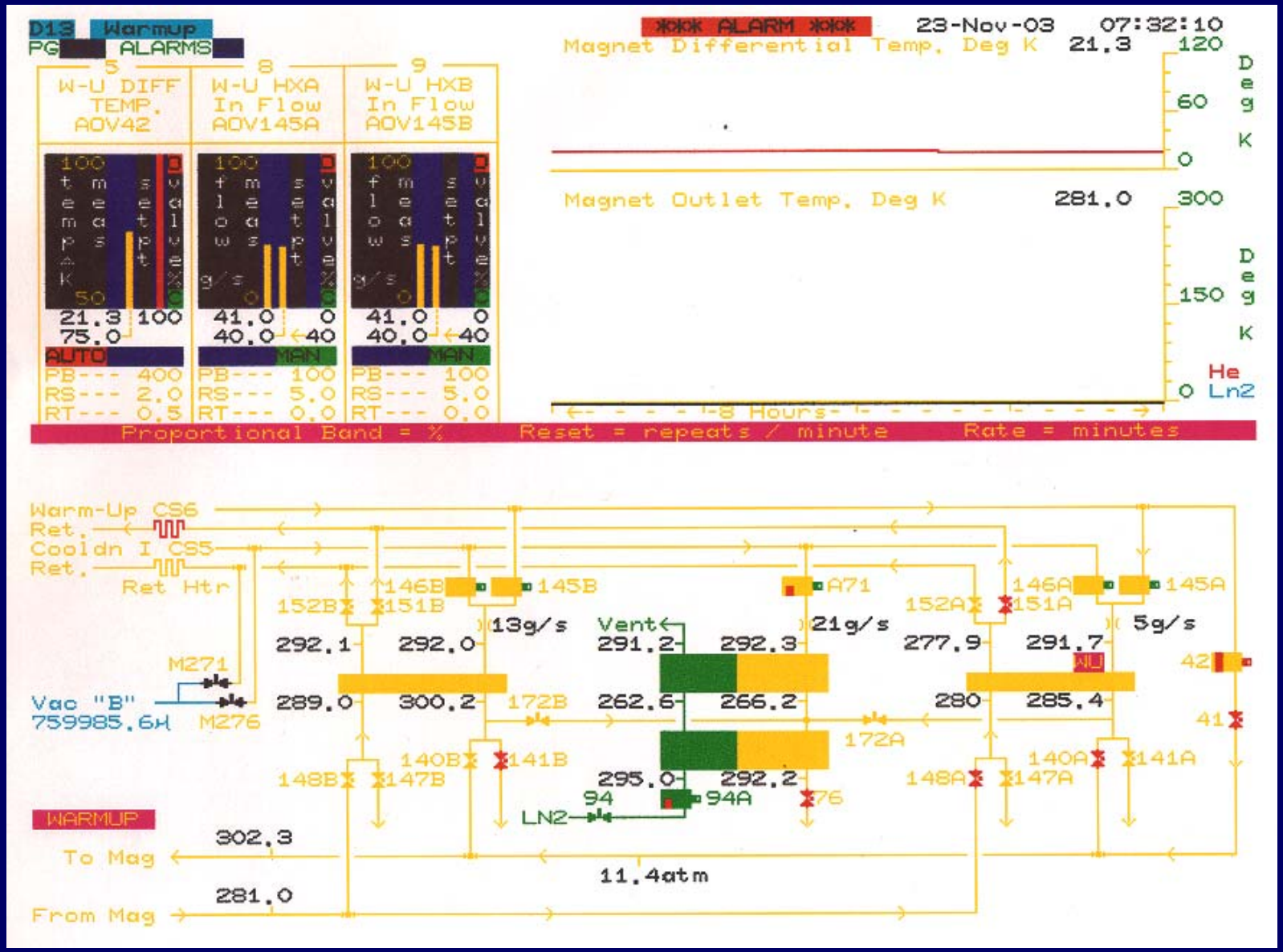
Liquid Cooling of D2L109 for ramping to 6825 A



Lead Flow and Current During Ramping of D2L109 – Liquid Cool
Ramp rate is 20 A/s. Below 10 A, Tare flow is 0.10 g/s. Above 10 A, Tare flow is 0.20 g/s for (+) lead & 0.35 g/s for (-) lead. Wait ~ 2min for voltage recovery at 5000 A. Curves appear to be different from previous tests because the time scale is 120 min. as field measurement (not for quench test).
Upper Figure: Lead Flow – Blue for (-) Lead and Red for (+) Lead. Lower Figure: Current as a Function of Time



Process Control for Warmup D2L109 – 11/21/03



Summary

- Complete quench test and field measurement for D2L109 with two warm bore tubes.